Advanced Image Processing - Morphology

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Definition

Definition - binary image

Let $E \subseteq \mathbb{Z}^d$ be a grid and A is its subset, then this subset is a binary image.

Definition - structural element

Structural element B is also a binary image, e.g. $B \subseteq E$. It can also be moved which we denote as $B_z = \{b + z | b \in B\}$ for $\forall z \in E$.

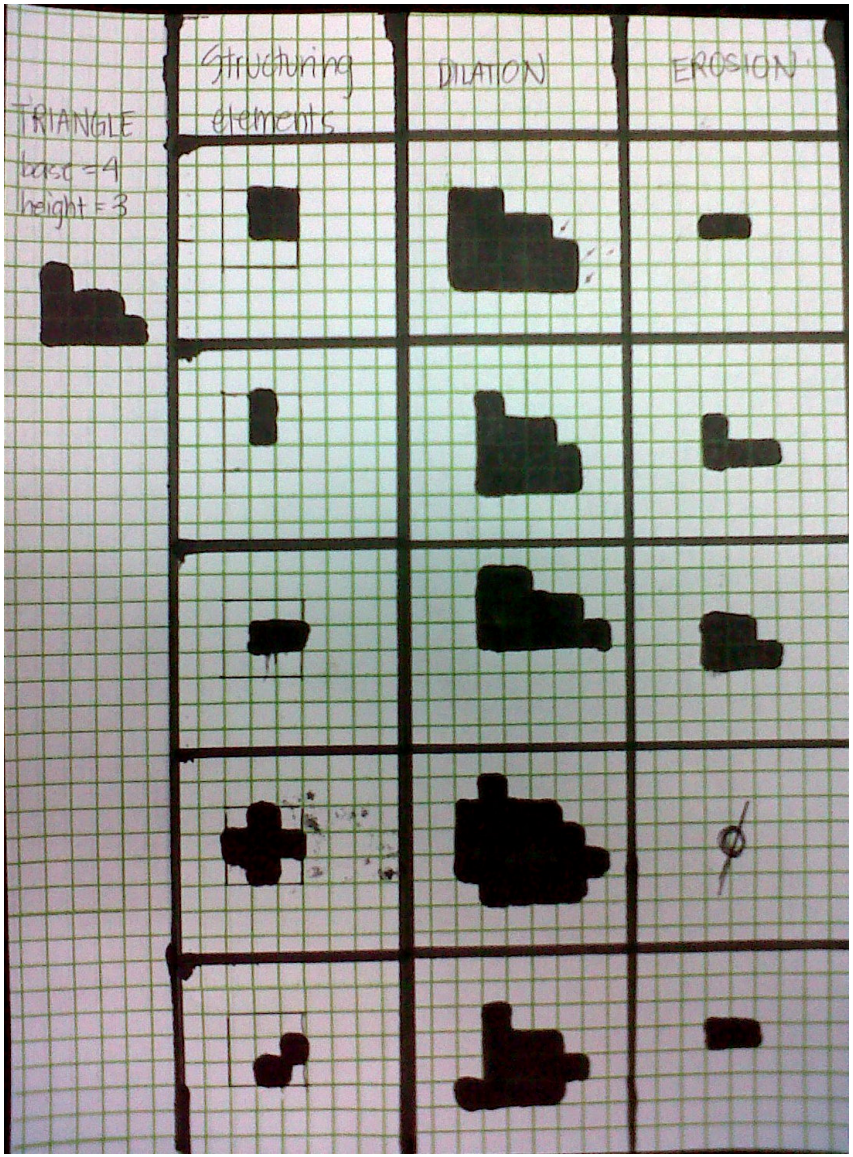
Definition - erosion

Erosion $A \ominus B = \{z \in E | B_z \subseteq A\}$.

Definition - dilation

Dilation $A \oplus B = \bigcup_{a \in A} B_a$

Intuitive explanation



Matlab

strel

SE = strel(name, params) - returns structural element with given parameters. Names are 'diamond', 'disk', 'line', 'octagon', 'rectangle' a 'square'.

imerode

imerode(I,SE) - returns erosion of image I with structural element SE. Works also for grayscale, but we will leave that for the next week.

imdilate

imdilate(I,SE) - returns dilation of image I with structural element SE. Works also for grayscale, but we will leave that for the next week.

Exercise

Properties

Commutativity

$A \oplus B = B \oplus A$

Associativity

$A \oplus (B \oplus C) = (A \oplus B) \oplus C$

Shift invariance

$A \oplus B_z = (A \oplus B)_z$

Duality

Erosion and dilation are mutually dual. E.g. erosion of the image is the same as dilation if the inverse image and vice versa.

Definitions

Definition - closing

Closing A with structural element B is $(A \oplus B) \ominus B$. Closing usually fills holes in the binary image.

Definition - opening

Opening A with structural element B is $(A \ominus B) \oplus B$. Opening usually removes smaller objects such as noise from image.

Matlab - opening and closing

imopen

imclose(I, SE) - returns closing of image I with structural element SE

imopen

imopen(I, SE) - returns opening of image I with structural element SE

regionprops

s = regionprops(BW, 'Centroid') - returns a struct containing field Centroi which contains the centers of individual objects in the binary image.

Exercises

Exercise

Use morpholigal operations to count the circles in image connected.png and lines_and_circles.png.

Exercise

Use adaptive thresholding, filtration and morphological operations to count the large circles in Kruhy.jpg.

Exercise

Use morphological operations to remove the artefacts from the image fingerprint.png.

Exercise

Use morphological operations to find holes in the fence in the image fence.png.

Edges

Edge detection

We can use morphological operations to find edges of objects. For a binary image I we can find edges if we one of the logical rules $I \neq I \ominus SE$, $I \neq I \oplus SE$, or $I \ominus SE \neq I \oplus SE$.

Exercise

Find edges in the image motyle.png. Try to use different SEs.

Hit-miss

Hit-miss

Hit-miss transforms the image using two structural elements so that $HM = I \ominus SE_1 \cap (E/I) \ominus SE_2$. In other words only those pixels remain where SE_1 'fits' a SE_2 doesn't.

bwhitmiss

bwhitmiss(BW, SE1, SE2) - returns hit-miss according to the definition

bwhitmiss

bwhitmiss(BW, interval) - Same as bwhitmiss(BW, interval == 1, interval == -1)

Exercise

Find corners in boxes.png using Hit-miss.